Energy Management Study

for

General Leonard Wood Army Community Hospital

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William Tao & Associates
Consulting Engineers

GENERAL LEONARD WOOD ARMY COMMUNITY HOSPITAL
ENERGY MANAGEMENT STUDY

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I. EXECUTIVE SUMMARY

A. INTRODUCTION

William Tao & Associates, Inc. (WTA) was commissioned by the United States Army Corps of Engineers (COE) to perform an Energy Management Study of the General Leonard Wood Army Community Hospital (GLWACH). The Hospital is a 366,000 SF facility, with scheduled capacity of 450 patient beds, with a two-story clinical area as a base and a five-story patient tower above. The Hospital was constructed in 1965; in 1978 the patient tower and outpatient clinics were expanded; and in 1981 the Medical Warehouse was completed.

The Energy Management Study consists of several phases including but not limited to data collection, data refinement, concept development, energy modeling, developing a utility metering plan and documentation of alternatives and recommendations. This submittal presents finding of the Energy Management Study and provides recommendations for implementation.

1. In detail this report presents the following information:

   - Complete energy audit and analysis of the entire Hospital facility.
   - Metering plan for the facility.
   - All Energy Conservation Opportunities (ECO) and performs complete evaluations, including low cost/no cost items.
   - Project documentation for Military Construction Projects (DD Form 1391) and Project Development Brochure (PDB).
   - Implementation documentation for all justifiable energy conservation opportunities.
   - Lists and priorities for all recommended energy conservation projects.
   - Comprehensive report which documents the work accomplished, the results, and the recommendations.

2. Implementation of the measures outlined herein will result in substantial improvement in energy savings within life cycle cost restrictions of the GLWACH complex. Modifications to GLWACH identified within the study include:

   - Physical alterations to the facility.
   - Modifications in operation methods.
   - Improved maintenance procedures.
   - Expanding EMCS functions.
   - Modifications in procedures in support services.

3. Acknowledgements

WTA wishes to acknowledge the cooperation of Mr. Mike Gunzel, COE Project Manager, Mr. John Morrissey, P.E., GLWACH Director of Engineering, Capt. Doris Jenkins and Capt. Dennis Payne, GLWACH Logistics Officers, and the many GLWACH employees, staff members and Command Officers who assisted in the investigation and development necessary in performing this study.

B. ANNUAL ENERGY CONSUMPTION

1. Electricity

As indicated in the the Energy Metering Plan (Volume 7), utilities are manually recorded at FLW. Until November 1983, metering of electrical usage at GLWACH has not been feasible due to broken primary service selector switches, resulting in a large amount of unmetered electrical energy. Plotting of data prior to November 1983 would lead to incorrect conclusions based on erroneous data. The table below illustrates electrical energy consumption from November 1983 through October 1984. Electrical demand data is not available. Therefore the costs for electrical service indicated are for energy only, approximately 50 percent of the total electrical bill.

TABLE I-B-1
ELECTRICAL ENERGY CONSUMPTION

Year	Month	KWH	Site MBTU	Cost ($)
1983	December	994,800	3,390	21,900
1984	January	1,038,000	3,540	22,800
	February	1,100,400	3,750	24,200
	March	1,014,000	3,460	22,300
	April	948,000	3,230	20,900
	May	1,122,000	3,830	24,700
	June	1,114,800	3,800	24,500
	July	1,070,400	3,650	23,500
	August	1,392,400	4,750	30,600
	September	981,600	3,350	21,600
	October	1,128,000	3,850	24,800
	November	878,400	3,000	19,300
	TOTAL	12,782,800	43,600	281,100

Data indicates an yearly usage of 12,800,000 KWH's of electricity. Based on a gross area of 366,000 SF, 119,000 BTU/SF/Year are used. From examination of usage profiles base (minimum monthly) electrical usage (usage not affected by climate variables) is estimated at 800,000 KWH/Month.

2. Fuel Oil Consumption

Boiler plant oil consumption is manually recorded by plant personnel hourly. The following table identifies consumption of #6 fuel oil by the Boiler Plant from January 1981 through October 1984. Current rates have been utilized to determine fuel oil costs.

TABLE I-B-2
FUEL OIL CONSUMPTION

Month	1981 Usage (Gal)	1981 Source MBTU	1981 Cost ($)	1982 Usage (Gal)	1982 Source MBTU	1982 Cost ($)
January	76,740	10,700	66,100	77,932	10,900	67,100
February	65,632	9,200	56,600	63,903	8,950	55,000
March	52,000*	7,280	44,800	52,150	7,300	44,900
April	48,770	6,830	42,000	47,388	6,630	40,800
May	39,680	5,550	34,200	35,830	5,020	30,800
June	26,122	3,660	22,500	32,840	4,600	28,300
July	23,166	3,240	19,900	28,000*	3,920	24,100
August	24,352	3,410	21,000	26,197	3,670	22,600
September	27,685	3,880	23,800	30,166	4,220	26,000
October	40,362	5,650	34,800	40,197	5,630	34,600
November	49,422	6,920	42,600	52,416	7,340	45,100
December	68,518	9,590	59,000	57,144	8,000	49,200
TOTAL	542,449	75,910	467,300	544,163	76,180	468,500

Month	1983 Usage (Gal)	1983 Source MBTU	1983 Cost ($)	1984 Usage (Gal)	1984 Source MBTU	1984 Cost ($)
January	63,074	8,830	54,300	62,226	8,710	53,600
February	52,460	7,340	45,200	43,942	5,150	37,800
March	53,853	7,540	46,400	53,870	7,540	46,400
April	43,195	6,050	37,200	32,769	4,590	28,200
May	43,195	6,050	37,200	30,999	4,340	26,700
June	32,098	4,490	27,600	28,739	4,020	24,700
July	26,387	3,690	22,700	20,745	2,900	17,900
August	21,197	2,970	18,300	18,895	2,650	16,300
September	21,103	2,950	18,200	20,767	2,900	17,900
October	34,237	4,790	29,500	28,648	4,010	24,700
November	28,100	3,930	24,200	--	--	--
December	60,364	8,450	52,000	--	--	--
TOTAL	479,263	67,080	412,800	341,600	46,810	294,200

* Estimated

Analysis of data indicates an average yearly usage of 503,000 gallons of fuel. Based on a gross area of 366,000 SF, 192,000 BTU/SF/Year is used. From examination of usage profiles base fuel oil usage (usage not affected by climate variables) is approximately 18,000 Gallons/ Month.

3. Energy Budget

Total energy consumption at GLWACH is 327,000 BTU/SF, with a annual operating budget of $622,000 not including electrical demand charges. The following table illustrates energy consumption at GLWACH with comparable institutions operated by the Veterans Administration:

TABLE I-B-3
COMPARATIVE FACILITY ENERGY CONSUMPTION (1981)

Facility	BTU/SF/Year
Wichita, Kansas	260,000
Leavenworth, Kansas	312,000
Topeka, Kansas	326,000
GLWACH	327,000
Kansas City, Missouri	327,000
St. Louis, Missouri	331,000
Marion, Illinois	459,000
Columbia, Missouri	505,000
Poplar Bluff, Missouri	551,000

Although only one complete year of energy data is available, analysis indicates that the Hospital would rank in the top half of the survey.

4. Normalized Energy Data

Tracking Relative Energy Consumption (TREC), a WTA program, has been utilized to normalize energy consumption to degree days (An abstract is included in Volume 2). Charts and tables are provided in Section VI - Historical Energy Data of the narrative report. These identify monthly fuel oil usage between January 1981 and October 1984 for the GLWACH Boiler Plant. Electric usage is included only from December 1983 to October 1984.

5. Breakout of Energy Consumption

Energy consumption within GLWACH is presently not submetered; a breakout of actual energy consumption by department or area is not possible.

6. Metering Plan

As required, WTA developed a metering plan for energy services provided to GLWACH. After consultation with many of the individuals involved, it was determined that a stand-alone metering system which will record energy usage and generate profile use for utility services would be the most economical approach for acquisition of one year's data. The following guidelines were utilized to determine metered energy systems:

a. All primary utility services to the Hospital or Boiler Plant will be metered (oil and electricity).

b. All primary energy transport systems from primary equipment to the Hospital will be metered (chilled water and steam).

WTA proposed a system in accordance with the Hospital's input that provided for manual collection of data and analysis by WTA engineers.

C. ENERGY CONSERVATION ANALYSIS

1. The following is a listing of Energy Conservation Opportunities (ECO) evaluated for implementation at GLWACH. The listing includes the ECO reference number and title. A complete explanation of each opportunity and the Annex A reference number is provided in the Narrative Report. All ECO's meet all current criteria for medical facilities.

TABLE I-C-1

PASSIVE MEASURES:

A-2	Install Insulating Wall Panels.
A-3	Install Insulation to Perimeter Walls.
A-5	Install Additional Roof Insulation.
A-6	Operate Entry Vestibules Effectively.
A-7	Install Entry Vestibules to Secondary Entrances.
A-9	Install Storm Sash.
A-10	Install Solar Control Film.
A-11	Retrofit Glazing Systems with Solar Control Glass.
A-12	Reduce Infiltration By Caulking and Weatherstripping.
A-13	Install Loading Dock Seals.

LIGHTING SYSTEMS:

B-2	Replace Incandescent Lighting Systems.
B-3	Establish a Lights-Off Policy for Unoccupied Spaces.
B-4	Turn Off Unnecessary Lighting During Unoccupied Periods.
B-5	Replace Type R or PAR with Type ER Incandescent Lamps.
B-6	Reduce Illumination Levels.
B-7	Remove Unnecessary Lamps.
B-8	Disconnect Delamped Ballasts.
B-9	Stock 34-Watt Energy-Conserving Lamps.
B-10	Stock High-Efficiency Ballasts.
B-11	Install AC Rectifiers in Incandescent Luminaires.
B-12	Install Fluorescent Dimming Lamps.
B-13	Group Relamp Fluorescent Fixtures.
B-14	Provide Proper Luminaire Maintenance.
B-15	Install Fluorescent Dimming Systems.
B-16	Control Lighting Systems by Motion Sensors.
B-17	Replace Site Lighting Systems.
B-18	Install Photoelectric Cells to Control Lighting Systems.
B-19	Replace Incandescent Exit Signs.

AIR HANDLING SYSTEMS:

C-2 Control Air Handling Units by Seven-Day Timer.
C-3 Cycle Units from Space Thermostats.
C-4 Reset Minimum Outdoor Air Dampers.
C-5 Schedule Outside Air Ventilation Rates.
C-6 Rebalance Air Handling Systems.
C-7 Retrofit Units for Economizer Operation.
C-8 Revert to Minimum Outside Air at 72°F.
C-9 Reset Mixed Air Temperature.
C-10 Install Variable Speed Control for Fan Systems.
C-11 Reset Space Thermostats.
C-12 Install Night Setback Thermostats.
C-13 Replace Reheat Coils with VAV Dampers.
C-14 Retrofit Multizone Units for VAV Operation.
C-15 Schedule Supply Air Volume Requirements.
C-16 Eliminate Air Supply to Unoccupied Areas in Headered Systems.
C-17 Reclaim Heat from Building Exhaust.
C-18 Abandon Unnecessary Humidification Devices.
C-19 Replace Water-Cooled Air Conditioning Units.
C-20 Install Energy-Efficient Motors.
C-21 Install Minimum-Sized Motor to Meet Loads.
C-22 Replace Hand Valves with Automatic Controls.
C-23 Not Used.

C-24 thru 62
Individual Air Handling System Analyses (37 Analyses).

TERMINAL HEATING SYSTEMS:

D-2 Abandon Unnecessary Terminal Heating Systems.
D-3 Reset Perimeter Radiation Set Points in Office Areas.
D-4 Reset Perimeter Set Points in Stairwells and Other Transient Areas.
D-5 Install Night Setback Thermostats.
D-6 Eliminate Operation of Perimeter Heating Devices in the Summer.
D-7 Maintain Proper Sequencing of Perimeter Radiation.
D-8 Reduce Speed of Fan Coil Units.

PIPING SYSTEMS:

E-2 Replace Ineffective or Damaged Steam Pipe Insulation.
E-3 Replace Ineffective or Damaged Chilled Water Pipe Insulation.
E-4 Repair Ineffective or Damaged Hot Water Pipe Insulation.
E-5 Use Circulating Pumps Only when Required.
E-6 Repair or Replace Damaged Steam Traps.
E-7 Reduce Pumping Flow.

PRIMARY HEATING SYSTEMS

F-4 Replace Inefficient Boilers.
F-5 Improve Sequencing of Multiple Boilers.
F-6 Reduce Steam Distribution Pressure.
F-7 Reclaim Heat from Stack Gas.
F-8 Repair Condensate Return System.
F-9 Optimize Fuel-Air Ratio Automatically.
F-10 Reclaim Heat from Boiler Blowdown.
F-11 Shut Off Steam to Laundry when Not in Use.
F-12 Install Incinerator Heat Recovery System.

PRIMARY COOLING SYSTEMS:

G-3 Replace Inefficient Refrigeration Equipment.
G-4 Enable Pumps by Ambient Temperature Sensor.
G-5 Reset Cooling Tower Freeze Protection System.
G-6 Install Immersion Heating Systems in Tower Sump.
G-7 Sequence Chillers by Return Water Temperature.
G-8 Chilled Water Piping Systems.
G-9 Condenser Water Piping Systems.
G-10 Cycle Chilled and Condenser Water Pumps.
G-11 Rebalance Chilled and Condenser Water Pumps.
G-12 Reduce Chilled Water Circulated During Light Cooling Loads.
G-13 Reduce Condenser Water Temperature Set Point.
G-14 Reset Chilled Water Supply Temperature.

DOMESTIC HOT WATER:

H-2 Reset Domestic Hot Water Temperatures.
H-3 Install Water-Conserving Shower Heads.
H-4 Install Flow Restrictors.
H-5 Install Faucets Which Automatically Shut Off Water Flow.
H-6 Operate Circulating Pumps Effectively.
H-7 Decentralize Domestic Hot Water Heating.

ELECTRICAL SYSTEMS:

I-1 Shut Off Elevators Whenever Possible.
I-2 Shut Off Pneumatic Tube System Whenever Possible.
I-3 Install Capacitors at Synchronous Motors to Increase Power Factor.
I-4 Use Emergency Generators to Reduce Peak Demand.

ENERGY MANAGEMENT CONTROL SYSTEM (EMCS)

J-1 Existing EMCS System.
J-2 Existing EMCS Characteristics
J-3 Upgrade or Replace Existing EMCS.
J-4 Provide Communications between GLWACH EMCS and Base-Wide EMCS.
J-5 Data Transmission
J-6 Integrate Fire Safety and Smoke Control Functions into EMCS.
J-7 Proposed Additional EMCS Functions
J-8 Project Savings
J-9 System Survey
J-10 Point Listing
J-11 Energy Savings

KITCHEN SERVICES

K-1 Shut Off Range Hood Exhaust Whenever Possible.
K-2 Install High-Efficiency Steam Control Valves.
K-3 Shut Off Equipment and Appliances Whenever Possible.
K-4 Install Makeup Air Supply for Exhaust.
K-5 Install Heat Reclamation System for Exhaust Heat.
K-6 Reset Temperature on Coolers and Freezers.
K-7 Observe Load Limit on Refrigerated Food Cases.
K-8 Store Food Away from Coils and Fans.
K-9 Stack Refrigerated Products for Proper Air Circulation.
K-10 Minimize Out-of-Stock in Refrigerated Cases.
K-11 Do Not Stack Products Over Return Air Grilles.
K-12 Transfer Refrigerated Food as Quickly as Possible.
K-13 Keep Freezer or Cooler Doors Closed.
K-14 Place Food Requiring Like Temperatures in One Unit.
K-15 Turn Lights Off in Refrigerated Cases.
K-16 Clean Cases as Recommended.
K-17 Flush Refrigeration Components to Prevent Ice Buildup.
K-18 Check Freezer and Case Temperatures.
K-19 Use Timers to Cycle Refrigeration.
K-20 Have Refrigeration Equipment Checked Periodically.
K-21 Replace Door Seals Which Have Deteriorated.
K-22 Maintain Proper Amount of Refrigerant.
K-23 Check Fan Motors to Insure Proper Functioning.
K-24 Implement Heat Reclaim from Refrigeration Units.
K-25 Turn Heat Down As Soon As Food Begins to Boil.
K-26 Use Lids to Retain Air in Pots.
K-27 Preheat Fryers to Manufacturer's Recommendations.
K-28 Turn Off Fryers During Slack Periods.
K-29 Turn Fryer Thermostat Only to 325-350°F.
K-30 Use Electric Ovens During Off-Peak Demand Hours.
K-31 Minimize Preheating Ovens.
K-32 Load Ovens to Capacity.
K-33 Load the Entire Oven at Once.
K-34 Use Timers to Avoid Opening Oven Doors.

SOLAR ENERGY:

L-2 Solar Space Cooling.
L-3 Solar Space Heating.
L-4 Domestic Hot Water Preheating.
L-5 Conclusions

2. Prior and Continuing Energy Conservation Projects:

GLWACH has initiated retrofit of window systems with solar-tinted insulating glazing. In addition, the Hospital is considering expansion of the Delta 2000 to control the emergency generator system. Both projects are completely compatible with this document.

3. Energy Management Control System Recommendations:

GLWACH has installed and is operating an EMCS manufactured by Honeywell, Inc., a Delta 2000. At the time of installation, this was a state-of-the-art automation system. The existing system features programmed stop-start, monitoring, limited set point and controller adjustment, tabular and projected graphic display. The EMCS is in excellent repair and has been enhanced and enlarged to its present condition. A full listing of points included is provided in Section V - Historical Energy Data.

Honeywell has replaced the Delta 2000 system in their market line with the new generation Delta 1000 system. There are differences in panel types and communication systems that do not allow direct upgrade from the existing system to a Delta 1000 configuration. However, Honeywell can supply system hardware and software in association with a Delta 1000 upgrade to utilize 100 percent of the existing field cabinets, wiring and sensors. This would allow upgrade to a Delta 1000 with minimum disturbance to and optimum use of existing systems.

GLWACH personnel are intimately familiar with this system and are extremely pleased with its performance. WTA recommends that the existing EMCS be upgraded to take advantage of existing hardware and personnel training. Both economy and reliability of the proposed system indicate that the Delta 2000 be upgraded to a Delta 1000 configuration. A complete listing of new points are provided in Section VII - J of the narrative report.

a. Proposed Additional EMCS Functions

Features to be added by upgrading to Delta 1000 Configuration:

Programmed Start-Stop of Energy Systems to Follow Occupancy Usage Patterns
Control Point Reset
Optimized Start-Stop Program
EMCS Controlled Duty Cycling
EMCS Controlled Demand Limiting (Load Shedding)
Equipment Sequence Control
Graphics

Optional Features which may be included in the upgrade or in the future:

Fire Alarm Integration
Building Management Reports
Historical Energy Data
Distributive Processing

b. EMCS Upgrade Cost and Savings

Total direct energy management savings are $44,600. In addition, throughout the report other savings are attributable to this system. The projected cost to upgrade the EMCS is estimated at $446,000. The resulting payback is therefore 10 years with a savings investment ratio of 1.0. WTA recommends upgrading the existing Delta 2000 to a Delta 1000 configuration.

3. ECIP Projects Developed: With the Hospital staff, the following ECIP projects have been developed for implementation:

TABLE I-C-2
ECIP PROJECT #1

EMO	Item Description	Cost
C-26	Modify Air Handling System 1B	$ 150
C-27	Modify Air Handling System 2	2,100
C-29	Modify Air Handling System 3	3,370
C-32	Modify Air Handling System 4A	15,900
C-33	Modify Air Handling System 5	2,600
C-34	Modify Air Handling System 5A	4,850
C-35	Modify Air Handling System 6	13,100
C-36	Modify Air Handling System 6A	14,100
C-37	Modify Air Handling System 7	13,100
C-38	Modify Air Handling System 7A	4,650
C-39	Modify Air Handling System 8	20,400
C-40	Modify Air Handling System 8A	7,620
C-43	Modify Air Handling System 10	4,700
C-44	Modify Air Handling System 10A	4,420
C-45	Modify Air Handling System 11	4,100
C-47	Modify Air Handling System 12	100
C-49	Modify Air Handling System 13	6,100
C-50	Modify Air Handling System 14	5,600
C-51	Modify Air Handling System 15	12,100

ECIP PROJECT #1 (CONTINUED)

EMO	Item Description	Cost
C-52	Modify Air Handling System 16	$ 11,500
C-53	Modify Air Handling System 17	3,100
C-58	Modify Air Handling System 36	210
C-58	Modify Air Handling System 37	210
C-58	Modify Air Handling System 38	210
C-58	Modify Air Handling System 39	210
C-58	Modify Air Handling System 40	210
C-58	Modify Air Handling System 41	210
C-58	Modify Air Handling System 42	210
D-5	Install Night Setback Thermostats	1,700
	Operate Circulating Pumps Effectively	2,000
J-12	EMCS	446,000
	TOTAL ECIP PROJECT #1	$604,830

TABLE I-C-3
ECIP PROJECT #2

EMO	Item Description	Cost
A-7	Install Entry Vestibules to Secondary Entrances	11,300
B-2	Replace Incandescent Lighting Systems	24,900
B-16	Control Lighting Systems from Motion Sensors	20,600
B-19	Replace Incandescent Exit Signs	7,000
F-7	Reclaim Heat from Stack Gas	220,000
G-4	Enable Pumps by Ambient Temperature Sensor	2,800
G-6	Install Immersion Heating Systems in Tower Sump	15,000
G-8	Chilled Water Piping Systems	50,000
H-3	Install Water-Conserving Shower Heads	15,000
H-4	Install Flow Restrictors	20,000
	TOTAL ECIP PROJECT #2	386,600

4. Other Energy Conservation Projects: With the Hospital staff, the following QRIP project has been developed for implementation.

TABLE I-C-4
QRIP PROJECT

EMO	Item Description	Cost
A-13	Install Loading Dock Seals	$ 5,000
C-28	Modify Air Handling System 2A	2,900
C-30	Modify Air Handling System 3A	3,470
C-31	Modify Air Handling System 4	29
C-41	Modify Air Handling System 9	4,300
C-42	Modify Air Handling System 9A	7,200
C-48	Modify Air Handling System 12A	5,600
C-54	Modify Air Handling System 18	120
C-55	Modify Air Handling System 19	120
C-56	Modify Air Handling System 20	200
C-57	Modify Air Handling System HV-1	1,150
F-6	Reduce Steam Distribution Pressure	700
G-7	Sequence Chillers by Return Water Temperature	50
G-11	Rebalance Chilled and Condenser Water Pumps	3,250
	TOTAL QRIP PROJECT	$34,089

5. Operational or Policy Change Recommendations: WTA recommends the following modifications and enhancements to building operations:

TABLE I-C-5

ECO	
A-12	Maintain Weatherstripping and Caulking Adequately
B-3	Establish a Lights-off Policy for Unoccupied Spaces
B-4	Turn Off Unnecessary Lighting During Unoccupied Periods
E-2	Replace Ineffective or Damaged Steam Pipe Insulation
E-3	Replace Ineffective or Damaged Chilled Water Pipe Insulation
E-4	Repair Ineffective or Damaged Hot Water Pipe Insulation
E-6	Repair or Replace Damaged Steam Traps
G-5	Reset Cooling Tower Freeze Protection System
H-2	Reset Domestic Hot Water Temperatures
H-6	Operate Circulating Pumps Effectively
K-6	Reset Temperature on Coolers and Freezers.
K-7	Observe Load Limit on Refrigerated Food Cases.
K-8	Store Food Away from Coils and Fans.
K-9	Stack Refrigerated Products for Proper Air Circulation.
K-10	Minimize Out-of-Stock in Refrigerated Cases.
K-11	Do Not Stack Products Over Return Air Grilles.
K-12	Transfer Refrigerated Food as Quickly as Possible.
K-13	Keep Freezer or Cooler Doors Closed.
K-14	Place Food Requiring Like Temperatures in One Unit.
K-15	Turn Lights Off in Refrigerated Cases.
K-16	Clean Cases as Recommended.

K-17 Flush Refrigeration Components to Prevent Ice Build-up.
K-18 Check Freezer and Case Temperatures.
K-19 Use Timers to Cycle Refrigeration.
K-20 Have Refrigeration Equipment Checked Periodically.
K-21 Replace Door Seals Which Have Deteriorated.
K-22 Maintain Proper Amount of Refrigerant.
K-23 Check Fan Motors to Insure Proper Functioning.
K-24 Implement Heat Reclaim from Refrigeration Units.
K-25 Turn Heat Down As Soon As Food Begins to Boil.
K-26 Use Lids to Retain Air in Pots.
K-27 Preheat Fryers to Manufacturer's Recommendations.
K-28 Turn-Off Fryers During Slack Periods.
K-29 Turn Fryer Thermostat Only to 325-350°F.
K-30 Use Electric Ovens During Off-Peak Demand Hours.
K-31 Minimize Preheating of Ovens.
K-32 Load Ovens to Capacity.
K-33 Load Entire Oven at Once.
K-34 Use Timers to Avoid Opening Oven Doors.
K-35 Use Secondary Ovens Only When Schedules Overlap.
K-36 Turn Off Ovens and Keep Them Closed When Not In Use.
K-37 Have Service Personnel Thoroughly Inspect Ovens.
K-38 Keep the Door Edge Free of Food Particles.
K-39 Keep Oven Wall and Heating Elements Clean.

D. ENERGY AND COST SAVINGS

The goal of an Energy Management Study is to improve the operation and reduce energy expenditures within life cycle cost guideline restrictions of the facility being studied. The following table presents average energy consumption and projected savings by implementing the suggestions in this study:

TABLE I-D-1
SUMMARY OF PROJECTED ENERGY SAVINGS

Energy Source	Average Consumption	Projected Savings	Percent Savings	Energy Cost ($) Existing	Energy Cost ($) Modified
Electric					
Usage	12,800 MWH	4,980 MWH	39	281,600	172,200
Demand[1]	--	1080 KW	--	62,600[2]	--
Fuel Oil	543,000 Gal	95,400 Gal	18	467,500	385,400
TOTAL[3]	119,700 MBTU	30,350 MBTU	25	811,700	557,600

Note: (1) Demand is not presently metered at GLWACH.
(2) Since GLWACH is charged only for energy consumption, Base-wide demand savings will be represented in total by adding avoided cost to existing operating costs.
(3) Total in MBTU (140,000 BTU/Gal. Oil; 3,413 BTU/KWH Elec)

Total energy savings are therefore worth $254,100. The total cost for implementation is $1,241,500 resulting in a 4.9 year payback period and a savings investment ratio of 2.2 for the entire project.

The following table demonstrates projected energy cost for GLWACH for 1985 through 2000. Both existing and modified facility costs are projected. Existing facility costs include demand charges to demonstrate total energy savings from project implementation. Fuel escalation rates have been determined from the Federal Register.

TABLE I-D-2
PROJECTED OPERATIONAL COSTS

Year	Existing Facility	Modified Facility
1985	811,700	557,600
1986	823,100	567,900
1987	835,000	578,500
1988	847,200	589,500
1989	860,000	600,800
1990	873,200	612,600
1991	896,000	631,400
1992	919,800	651,100
1993	944,500	671,500
1994	970,300	692,800
1995	997,200	715,000
1996	1,025,200	738,200
1997	1,054,500	762,200
1998	1,084,900	787,500
1999	1,116,700	813,600
TOTAL	14,059,300	9,970,200
SAVINGS		4,089,100

E. ENERGY PLAN

A structured package of energy conservation opportunities is recommended to produce maximum savings for the investment. This summary presents two sets of recommendations. The first set ranks energy conservation measures by SIR. Implementing measures as structured will provide an energy conservation program which maximizes the return-on-investment. The second set lists energy conservation measures from the least expensive to the most expensive (within ECIP economic criteria). Implementing measures in this order will structure an energy conservation program for minimal cost.

Three concepts are included with a SIR less than 1. These are included for building systems compatability. In addition, these items will have an SIR greater than one when new economic criteria is applied as indicated by the authorizing agency.

1. Listed in Order of Greatest to Least SIR

TABLE I-E-1
GENERAL LEONARD WOOD ARMY COMMUNITY HOSPITAL
ENERGY CONSERVATION PROJECTS

ECO	Project Description	Annual Savings ($/Year)	Project Cost ($)	Payback Period Years	SIR
B-4	Turn off Unnecessary Lighting During Unoccupied Periods	1,390	0	0	--
B-5	Replace Type R or PAR with Type ER Incandescent Lamps	1,290	0	0	--
C-46	Modify Air Handling System 11A	2,680	60	0.02	553
C-11	Reset Space Thermostats	23,300	1,000	0.04	279
G-5	Reset Cooling Tower Freeze Protection System	940	50	0.05	278
G-13	Reduce Condenser Water Temperature Set Point	1,100	50	0.05	246
A-6	Operate Entry Vestibules Effectively	380	50	0.2	91
D-4	Reset Perimeter Set Points in Stairwells and Other Transient Areas	429	60	0.13	86

GENERAL LEONARD WOOD ARMY COMMUNITY HOSPITAL
ENERGY CONSERVATION PROJECTS

ECO	Project Description	Annual Savings ($/Year)	Project Cost ($)	Payback Period Years	SIR
F-6	Reduce Steam Distribution Pressure	2,400	700	0.29	41
D-4	Reset Perimeter Radiation Set Points in Office Areas	305	95	0.31	36
C-56	Modify Air Handling System 20	550	200	0.36	31.7
C-57	Modify Air Handling System HV-1	1,970	1,150	0.58	20.6
C-28	Modify Air Handling System 2A	3,640	2,900	0.80	13.4
B-3	Establish A Lights-Off Policy for Unoccupied Spaces	8,850	9,000	1.0	10.2
B-7	Remove Unnecessary Lamps	13,200	15,950	1.2	8.7
C-31	Modify Air Handling System 4	22	29	1.3	8.1
C-54	Modify Air Handling System 18	87	120	1.4	7.4
C-55	Modify Air Handling System 19	87	120	1.4	7.4
C-48	Modify Air Handling System 12A	3,460	5,600	1.6	7.0
G-7	Sequence Chillers by Return Water Temperature	31	50	1.6	7.0
C-30	Modify Air Handling System 3A	2,180	3,470	1.5	6.9
C-42	Modify Air Handling System 9A	4,510	7,200	1.5	6.8
G-11	Rebalance Chilled and Condenser Water Pumps	2,090	3,250	1.6	6.7
A-13	Install Loading Dock Seals	2,660	5,000	1.9	6.4
C-41	Modify Air Handling System 9	3,310	4,300	1.1	5.9
B-10	Stock High-Efficiency Ballasts	15,800	29,700	1.9	5.4
C-32	Modify Air Handling System 4A	7,610	15,900	2.1	5.3

GENERAL LEONARD WOOD ARMY COMMUNITY HOSPITAL
ENERGY CONSERVATION PROJECTS

ECO	Project Description	Annual Savings ($/Year)	Project Cost ($)	Payback Period Years	SIR
B-2	Install Fluorescent Screw-in Replacement Lamps	706	1,410	2.0	5.2
B-12	Install Fluorescent Dimming Lamps (50 Percent)	3,100	2,000	0.6	5.0
C-38	Modify Air Handling System 7A	2,050	4,650	2.3	4.5
B-12	Install Fluorescent Dimming Lamps (33 Percent)	1,480	1,580	1.1	4.4
C-58	Modify Air Handling System 36	77	210	2.7	4.0
C-58	Modify Air Handling System 37	77	210	2.7	4.0
C-58	Modify Air Handling System 38	77	210	2.7	4.0
C-58	Modify Air Handling System 39	77	210	2.7	4.0
C-58	Modify Air Handling System 40	77	210	2.7	4.0
C-58	Modify Air Handling System 41	77	210	2.7	4.0
C-58	Modify Air Handling System 42	77	210	2.7	4.0
C-39	Modify Air Handling System 8	7,560	20,400	2.7	3.9
C-36	Modify Air Handling System 6A	4,980	14,100	2.8	3.9
C-34	Modify Air Handling System 5A	1,830	4,850	2.7	3.9
B-8	Disconnect Delamped Ballasts	335	910	2.7	3.9
C-49	Modify Air Handling System 13	2,020	6,100	3.0	3.7
C-44	Modify Air Handling System 10A	1,160	4,420	3.8	3.7
C-47	Modify Air Handling System 12	38	100	2.7	3.7
G-4	Enable Pumps by Ambient Temperature Sensor	580	2,800	4.8	3.3
A-7	Install Entry Vestibules to Secondary Entrances	3,080	11,300	3.7	3.3
C-27	Modify Air Handling System 2	595	2,100	3.5	3.2

GENERAL LEONARD WOOD ARMY COMMUNITY HOSPITAL
ENERGY CONSERVATION PROJECTS

ECO	Project Description	Annual Savings ($/Year)	Project Cost ($)	Payback Period Years	SIR
C-40	Modify Air Handling System 8A	2,210	7,620	3.5	3.1
C-35	Modify Air Handling System 6	3,530	13,100	3.7	2.9
H-4	Install Flow Restrictors	4,920	20,000	4.2	2.9
C-37	Modify Air Handling System 7	3,500	13,100	3.7	2.9
C-29	Modify Air Handling System 3	863	3,370	3.9	2.8
D-5	Install Night Setback Thermostats	406	1,700	4.2	2.7
C-52	Modify Air Handling System 16	2,670	11,500	4.3	2.6
C-33	Modify Air Handling System 5	520	2,600	5.0	2.2
H-3	Install Water-Conserving Shower Heads	2,460	15,000	6.3	2.0
C-43	Modify Air Handling System 10	1,510	4,700	3.1	2.0
G-6	Install Immersion Heating Systems in Tower Sump	2,400	15,000	6.3	1.9
C-51	Modify Air Handling System 15	1,940	12,100	6.2	1.8
B-2	Replace Incandescent Lighting Systems	4,140	24,900	6.0	1.7
B-16	Control Lighting Systems From Motion Sensors	2,860	20,600	7.2	1.7
C-26	Modify Air Handling System 1B	23	150	6.5	1.6
B-19	Replace Incandescent Exit Signs	1,090	7,000	6.5	1.5
C-25	Modify Air Handling System 1	187	1,450	7.7	1.4
F-7	Reclaim Heat from Stack Gas	23,300	220,000	9.4	1.3
G-8	Chilled Water Piping Systems	5,720	50,000	8.7	1.3
A-11	Retrofit Glazing Systems with Solar Control Glass	4,630	41,600	9.0	1.3

GENERAL LEONARD WOOD ARMY COMMUNITY HOSPITAL
ENERGY CONSERVATION PROJECTS

ECO	Project Description	Annual Savings ($/Year)	Project Cost ($)	Payback Period Years	SIR
C-45	Modify Air Handling System 11	530	4,100	7.7	1.3
C-50	Modify Air Handling System 14	690	5,600	8.1	1.3
C-26	Modify Air Handling System 1A	117	1,040	8.9	1.2
J-12	EMCS	44,600	446,000	10.0	1.0
C-53	Modify Air Handling System 17	270	3,100	11.5	0.95
H-6	Operate Circulating Pumps Effectively	166	2,000	12.0	0.87
K-4	Install Makeup Air Supply for Exhaust	8,280	110,000	23.4	0.83
TOTAL		254,100	1,241,524	4.9	2.7

2. Listed in Order of Initial Cost

TABLE I-D-2
GENERAL LEONARD WOOD ARMY COMMUNITY HOSPITAL
ENERGY CONSERVATION PROJECTS

ECO	Project Description	Annual Savings ($/Year)	Project Cost ($)	Payback Period Years	SIR
B-4	Turn off Unnecessary Lighting During Unoccupied Periods	1,390	0	0	--
B-5	Replace Type R or PAR with Type ER Incandescent Lamps	1,290	0	0	--
C-31	Modify Air Handling System 4	22	29	1.3	8.1
G-13	Reduce Condenser Water Temperature Set Point	1,100	50	0.05	246
G-5	Reset Cooling Tower Freeze Protection System	940	50	0.05	278

GENERAL LEONARD WOOD ARMY COMMUNITY HOSPITAL
ENERGY CONSERVATION PROJECTS

ECO	Project Description	Annual Savings ($/Year)	Project Cost ($)	Payback Period Years	SIR
A-6	Operate Entry Vestibules Effectively	380	50	0.2	91
G-7	Sequence Chillers by Return Water Temperature	31	50	1.6	7.0
C-46	Modify Air Handling System 11A	2,680	60	0.02	553
D-4	Reset Perimeter Set Points in Stairwells and Other Transient Areas	429	60	0.13	86
D-4	Reset Perimeter Radiation Set Points in Office Areas	305	95	0.31	36
C-47	Modify Air Handling System 12	38	100	2.7	3.7
C-54	Modify Air Handling System 18	87	120	1.4	7.4
C-55	Modify Air Handling System 19	87	120	1.4	7.4
C-26	Modify Air Handling System 1B	23	150	6.5	1.6
C-56	Modify Air Handling System 20	550	200	0.36	31.7
C-58	Modify Air Handling System 36	77	210	2.7	4.0
C-58	Modify Air Handling System 37	77	210	2.7	4.0
C-58	Modify Air Handling System 38	77	210	2.7	4.0
C-58	Modify Air Handling System 39	77	210	2.7	4.0
C-58	Modify Air Handling System 40	77	210	2.7	4.0
C-58	Modify Air Handling System 41	77	210	2.7	4.0
C-58	Modify Air Handling System 42	77	210	2.7	4.0
F-6	Reduce Steam Distribution Pressure	2,400	700	0.29	41
B-8	Disconnect Delamped Ballasts	335	910	2.7	3.9

GENERAL LEONARD WOOD ARMY COMMUNITY HOSPITAL
ENERGY CONSERVATION PROJECTS

ECO	Project Description	Annual Savings ($/Year)	Project Cost ($)	Payback Period Years	SIR
C-11	Reset Space Thermostats	23,300	1,000	0.04	279
C-26	Modify Air Handling System 1A	117	1,040	8.9	1.2
C-57	Modify Air Handling System HV-1	1,970	1,150	0.58	20.6
B-2	Install Fluorescent Screw-in Replacement Lamps	706	1,410	2.0	5.2
C-25	Modify Air Handling System 1	187	1,450	7.7	1.4
B-12	Install Fluorescent Dimming Lamps (33 Percent)	1,480	1,580	1.1	4.4
D-5	Install Night Setback Thermostats	406	1,700	4.2	2.7
B-12	Install Fluorescent Dimming Lamps (50 Percent)	3,100	2,000	0.6	5.0
H-6	Operate Circulating Pumps Effectively	166	2,000	12.0	0.87
C-27	Modify Air Handling System 2	595	2,100	3.5	3.2
C-33	Modify Air Handling System 5	520	2,600	5.0	2.2
G-4	Enable Pumps by Ambient Temperature Sensor	580	2,800	4.8	3.3
C-28	Modify Air Handling System 2A	3,640	2,900	0.80	13.4
C-53	Modify Air Handling System 17	270	3,100	11.5	0.95
G-11	Rebalance Chilled and Condenser Water Pumps	2,090	3,250	1.6	6.7
C-29	Modify Air Handling System 3	863	3,370	3.9	2.8
C-30	Modify Air Handling System 3A	2,180	3,470	1.5	6.9
C-45	Modify Air Handling System 11	530	4,100	7.7	1.3
C-41	Modify Air Handling System 9	3,310	4,300	1.1	5.9

GENERAL LEONARD WOOD ARMY COMMUNITY HOSPITAL
ENERGY CONSERVATION PROJECTS

ECO	Project Description	Annual Savings ($/Year)	Project Cost ($)	Payback Period Years	SIR
C-44	Modify Air Handling System 10A	1,160	4,420	3.8	3.7
C-38	Modify Air Handling System 7A	2,050	4,650	2.3	4.5
C-43	Modify Air Handling System 10	1,510	4,700	3.1	2.0
C-34	Modify Air Handling System 5A	1,830	4,850	2.7	3.9
A-13	Install Loading Dock Seals	2,660	5,000	1.9	6.4
C-48	Modify Air Handling System 12A	3,460	5,600	1.6	7.0
C-50	Modify Air Handling System 14	690	5,600	8.1	1.3
C-49	Modify Air Handling System 13	2,020	6,100	3.0	3.7
B-19	Replace Incandescent Exit Signs	1,090	7,000	6.5	1.5
C-42	Modify Air Handling System 9A	4,510	7,200	1.5	6.8
C-40	Modify Air Handling System 8A	2,210	7,620	3.5	3.1
B-3	Establish A Lights-Off Policy for Unoccupied Spaces	8,850	9,000	1.0	10.2
A-7	Install Entry Vestibules to Secondary Entrances	3,080	11,300	3.7	3.3
C-52	Modify Air Handling System 16	2,670	11,500	4.3	2.6
C-51	Modify Air Handling System 15	1,940	12,100	6.2	1.8
C-35	Modify Air Handling System 6	3,530	13,100	3.7	2.9
C-37	Modify Air Handling System 7	3,500	13,100	3.7	2.9
C-36	Modify Air Handling System 6A	4,980	14,100	2.8	3.9
H-3	Install Water-Conserving Shower Heads	2,460	15,000	6.3	2.0
G-6	Install Immersion Heating Systems in Tower Sump	2,400	15,000	6.3	1.9

GENERAL LEONARD WOOD ARMY COMMUNITY HOSPITAL
ENERGY CONSERVATION PROJECTS

ECO	Project Description	Annual Savings ($/Year)	Project Cost ($)	Payback Period Years	SIR
C-32	Modify Air Handling System 4A	7,610	15,900	2.1	5.3
B-7	Remove Unnecessary Lamps	13,200	15,950	1.2	8.7
H-4	Install Flow Restrictors	4,920	20,000	4.2	2.9
C-39	Modify Air Handling System 8	7,560	20,400	2.7	3.9
B-16	Control Lighting Systems From Motion Sensors	2,860	20,600	7.2	1.7
B-2	Replace Incandescent Lighting Systems	4,140	24,900	6.0	1.7
B-10	Stock High-Efficiency Ballasts	15,800	29,700	1.9	5.4
A-11	Retrofit Glazing Systems with Solar Control Glass	4,630	41,600	9.0	1.3
G-8	Chilled Water Piping Systems	5,720	50,000	8.7	1.3
K-4	Install Makeup Air Supply for Exhaust	8,280	110,000	23.4	0.83
F-7	Reclaim Heat from Stack Gas	23,300	220,000	9.4	1.3
J-12	EMCS	44,600	446,000	10.0	1.0
TOTAL		254,100	1,241,534	4.9	2.7

LIFE CYCLE COST ANALYSIS SUMMARY

LOCATION: FT. LEONARD WOOD REGION 7
PROJECT NO.: DACA41-83-C-0045
PROJECT TITLE: ENERGY MANAGEMENT STUDY FISCAL YEAR: 1985
ANALYSIS DATE: 05-29-1986 ECONOMIC LIFE: 15 YEARS

DISCRETE PORTION NAME: ECONOMIC SUMMARY RESULTING FROM IMPLEMENTATION OF ECO'S RECOMMENDED FOR GLWACH

PREPARED BY: WILLIAM TAO & ASSOCIATES

1. INVESTMENT

A.	CONSTRUCTION COST	1241500
B.	SIOH	0
C.	DESIGN COST	74490
D.	ENERGY CREDIT CALC (1A+1B+1C)*0.9	1184391
E.	SALVAGE VALUE (-)	0
F.	TOTAL INVESTMENT (1D-1E)	1184391

2. ENERGY SAVINGS (+/-)
BASE YEAR ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

		UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A.	ELEC.	6.446	16996.7	109560	10.5	1150387
B.	DIST	6.15	13360	82164	11.41	937491
C.	RESID	0	0	0	12.27	0
D.	NG	0	0	0	13.72	0
E.	COAL	0	0	0	15.15	0
F.	TOTAL		30356.7	$ 191724		$ 2087878

3. NONENERGY SAVINGS (+/-)

A.	ANNUAL RECURRING (+/-)	$ 62600
	(1). DISCOUNT FACTOR = 9.100001	
	(2). DISCOUNTED SAVINGS/COST	$ 569660
B.	NONRECURRING SAVINGS/COST	NONE
C.	TOTAL DISCOUNTED SAVINGS/COST	$ 569660
D.	NONENERGY DISCOUNTED SAVINGS IS EQUAL TO OR LESS THAN 25% OF TOTAL	

4.	FIRST YEAR DOLLAR SAVINGS	$ 254324
5.	TOTAL NET DISCOUNTED DOLLAR SAVINGS (SF5+3D)	$ 2657538
6.	DISCOUNT SAVINGS RATIO -SIR- (5/1F)	2.24